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MACROECONOMIC EFFECTS OF MONETARY POLICY IN THE EUROZONE

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Macroeconomic effects of monetary policy in the eurozone

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To study the macroeconomic effects of unconventional monetary policy across the different countries of the eurozone, I develop an identification scheme to disentangle conventional from non-conventional policy shocks, using futures contracts on overnight interest rates and the size of the European Central Bank balance sheet. Setting these shocks as endogenous variables in a structural vector autoregressive (SVAR) model, along with the CPI and the employment rate, estimated impulse response functions of policy to macroeconomic variables are studied.

I find that unconventional policy shocks generated mixed effects in inflation but had a positive impact on employment, with the exception of Portugal, Spain, Greece and Italy where the employment response is close to zero or negative. The heterogeneity that characterizes the responses shows that the monetary policy measures taken in recent years were not sufficient to stabilize the economies of the eurozone countries under more severe economic conditions.

1 Introduction

The severity of the financial turmoil in September 2008 and the economic crisis that followed forced central bankers to rethink their monetary policy toolkits. As risk-free short-term nominal rates neared or reached the zero lower bound, central bankers in the USA, the eurozone and England turned to unconventional policy actions as Japan had previously done, namely liquidity easing measures and quantitative easing. While the Federal Reserve and Bank of England engaged in massive asset purchases, the European Central Bank (ECB) opted to rely mainly on the provision of increased liquidity to banks. The poor economic performance of the euro area since the outbreak of the crisis has led to criticism of the path taken by the ECB.

In the aftermath of these policies, it is important to study their effects and efficacy, and to evaluate how their impacts differed across the different euro area countries. Possible heterogeneity in the variables' responses to policy may be a sign of an unsuccessful monetary union as the common monetary policy may be pro-cyclical in some members, namely in the situation where business cycles are asynchronous, thus amplifying existing misalignments.¹

In this thesis, I propose a way to identify conventional and unconventional monetary policy shocks of the ECB using Eonia rate futures and the total size of the ECB's Balance sheet, and assess their macroeconomic effects in the 12 countries that first joined the euro area. I find that both shocks have effects on inflation with the expected sign in the majority of the countries in the sample: a contractionary shock in the policy rate has a negative impact while an unexpected increase in the balance sheet size generates a positive effect. Regarding employment, positive policy rate shocks have a negative impact in most countries, while the effects of unconventional shocks are mixed.

The remainder of this work project is organized as follows: the next section presents some literature on monetary policy transmission and its macroeconomic effects in the eurozone, while Section 3 summarizes monetary policy of the ECB since its creation. In Section 4, I describe the construction of the policy shocks and the various SVAR models to be estimated, together with the data used. Section 5 contains the main results for the various specifications considered. Finally, Section 6 concludes.

2 Related Literature

Economists have long debated the mechanisms by which monetary policy affects economic variables. Bernanke (1993) provides a summary of the history of the field and of the main research developments around the topic.

Within the paradigm of complete information and perfectly competitive markets, monetary policy is believed to affect the real economy through the interest rate channel: when the central bank uses open market sales to drain reserves from the banking system it reduces the money supply, generating a contrived scarcity of medium of exchange that drives up short-term interest rates. Higher interest rates then depress aggregate demand by raising the cost of funds relative to the return on capital.

However, these assumptions came under criticism when economics of imperfect information shed new light on another transmission channel: that in addition to affecting short term interest

1. In Mundell (1968)'s optimum currency area theory, asymmetric shocks are a threat to the area member's real economies, as global monetary policy will not be the appropriate for the particular situation of each constituent region.

rates, monetary policy affects aggregate demand by influencing the availability or terms of new bank loans (Stiglitz and Weiss 1981). The transmission mechanism is that as the Central Bank drains reserves, banks, to keep their reserve ratio stable, decrease deposits by a much larger amount. Therefore, assets must be reduced including lending. Because of banks' peculiar and often unsubstitutable intermediary role, some borrowers must resort to more expensive sources of financing or are denied credit altogether. Bank-dependent firms are thus forced to cancel investments, reduce payrolls and inventories, and similar effects are observed on the consumer sector, which overall negatively impact aggregate demand. A famous model that translates this mechanism to an IS-LM framework is Bernanke and Blinder (1988).

Following the creation of the eurozone, several studies have addressed the issue of monetary policy transmission in a single-currency area. Many authors have worked on the identification of the transmission channels, quantifying and illustrating the effect of monetary policy on interest rates, credit markets and financial markets. However, macroeconomic effects, namely on aggregated output and on the price level are seldom reported.

Regarding the period before the recent financial crisis, Bondt (2002) presented evidence towards a faster transmission of market interest rates to bank retail rates following the creation of the European Monetary Union (EMU), which plausibly means that macroeconomic effects were also quicker to show after the single-currency introduction. Studying lending and deposit interest rates through a recursive VAR, Angeloni and Ehrmann (2003) find that after the EMU, the reaction of euro area banks to monetary shocks was stronger and more homogeneous, but they do not encounter changes in transmission velocity. Sørensen and Werner (2006) analyse the pass-through of market rate to the interest rate on six types of retail bank products, across ten eurozone countries and conclude that heterogeneity is very large in both magnitude and speed of adjustment.

More recently, economists have incorporated the crisis and post-crisis period in their samples and have focused on the effects of the non-traditional measures adopted by the ECB. Estimating a vector error correction model to study the relation between market interest rates and retail interest rates in the eurozone and in Belgium, Cordemans and Sola Perea (2011) state that the package of measures adopted by the ECB more than offset the risk premia increase observed on the interbank and, later, on bond markets, and that these measures were able to secure an efficient monetary policy transmission. They find the rise in sovereign debt yields to have only limited effect on business and household borrowing costs at the euro level, with the exception of those countries whose governments were at the heart of the sovereign debt crisis.

Rafiq and Mallick (2008) model a structural VAR with sign restrictions both upon impact and for some periods after the shock's impact to compare output and price responses to monetary policy in Germany, Italy and France. Their main result is a worrying heterogeneity, since only in

Germany is there evidence that a contractionary monetary policy shock leads to a fall in output. The disparate responses of output, both in magnitude and timing across the three countries are a symptom of different transmission mechanisms, and thus the authors conclude by questioning whether the ECB could improve the efficacy of its monetary policy by using national information about inflation and the output gap, rather than only focusing on euro area aggregates.

Ciccarelli, Maddaloni, and Peydró (2013) present a comprehensive assessment of the effects of monetary policy shocks between 2002 and 2011 for a panel of countries and argue that, before the Lehman Brothers bankruptcy, output and the price level responded slowly and weakly to monetary shocks. When extending the sample to include the post-crisis period, the effects are found to be faster and larger. Moreover, they also find the responses in countries under higher sovereign financial stress to be significantly stronger.

Creel, Hubert, and Vienne (2013) estimate recursive VARs for the four largest economies in the EMU to quantify the impact of conventional and non-conventional policy shocks on credit market rates and volumes between mid-2007 and the end of 2012, and conclude that traditional shocks—unexpected changes in the policy rate—had the expected effect, while non-traditional shocks generated almost negligible reactions. Different results are found by Peersman (2011) who, estimating a SVAR for the euro area, finds that both policy rate shocks and unconventional shocks (“innovations to credit supply caused by monetary policy actions that are orthogonal to the policy rate”) have similar macroeconomic consequences, namely a hump-shaped impact on output and permanent increase in the consumer price level. However, transmission of the latter type of shocks appears to be more sluggish.

Additional literature on the effects of unconventional policy is presented at the end of the next section, after the different measures implemented have been summarized.

3 Monetary policy in the eurozone

Since the introduction of the Euro in 1999, monetary policy in the countries which adopted the new currency is set by the ECB. The central bank obeys certain conditions: it is independent from any EU institution and from any government of an EU Member State, its policies are applied to all countries in the single-currency area and its first priority is to maintain inflation rates below, but close to, 2% over the medium term, which corresponds to the definition of price stability of the ECB's Governing Council. In assessing the risks to price stability, the bank uses economic and monetary analysis.

During the first eight years of the euro, the ECB was successful in the maintenance of price stability using the main refinancing operations rate (the main policy instrument). Two relevant developments should be mentioned during this period: the lowering of the rate throughout

2002, until it reached the minimum of 2% on June 2003, and the increase in the policy rates beginning in December 2005 which continued throughout 2006, accompanying the strong economic upturn.

As tensions started to build in the money-markets, with short-term rates on the rise and unexpectedly peaking in August 2007, the ECB reacted with provision of unlimited liquidity with overnight maturity, and later by allowing refinancing operation of larger maturities of three and six months. This liquidity management however, did not imply the start of expansionary policy, as the increase in the rates in July 2008 demonstrates. Only the bankruptcy of Lehman Brothers in September and the full-fledged financial crisis that followed would alter the monetary policy stance, with the central bank cutting the main refinancing rate by 50 basis points as soon as 15th October 2008. The rate was subsequently decreased until reaching 1% on May 2009.

Additionally, the ECB also began an extensive program of what it called “enhanced credit support”². These consist of non-conventional policies designed to ensure liquidity provision despite the breakdown of the interbank money market and the almost freezing of other short-term funding sources, and ultimately to support banks in the fulfillment of their intermediary role of credit providers to the economy. Within the non-conventional measures, some may be categorized as changes to the conditions of refinancing operations: the switch to fixed-rate and full-allotment basis, the easing of collateral requirements, meaning a broader set of assets was now eligible and, in line with the previous actions in 2007, an extension of the maturity of Long-term-refinancing operations (LTROs) from three months to six, and then to one year. Furthermore, the bank conducted two Very Long term refinancing operations with three year maturity, that jointly amounted to €1 trillion.

Other types of measures include the launching of the Covered Bonds Purchase Programme (CBPP) aimed at supporting markets for these bonds which were key to the financing of the banking sector. This lasted one year starting in May 2009 and totaled €40 billion. A second program began in November 2011, and was halted in October 2012 when purchases reached €16.4 billion.

As the liquidity problem that hit the sovereign debt markets of some countries in the eurozone could hamper the transmission of monetary policy, the ECB began, in May 2010, the Security Market Program (SMP), consisting of purchases of Greek, Irish, Portuguese, Italian and Spanish Government Bonds which totalled around €220 billion. The program was terminated in September 2012 and substituted by the Outright Monetary Transactions (OMT) which gave the ECB the option to buy unlimited government bonds of members of the euro area, as long as

2. As defined by the ECB: “The non-standard measures taken by the ECB/Eurosystem during the financial crisis with a view to supporting financing conditions and credit flows above and beyond what could be achieved through reductions in key ECB interest rates alone.”

they meet the conditions of the European Stability Mechanism Programme. This option, while generating substantial falls in bond yields across the eurozone, was, however, never used by the Central Bank.

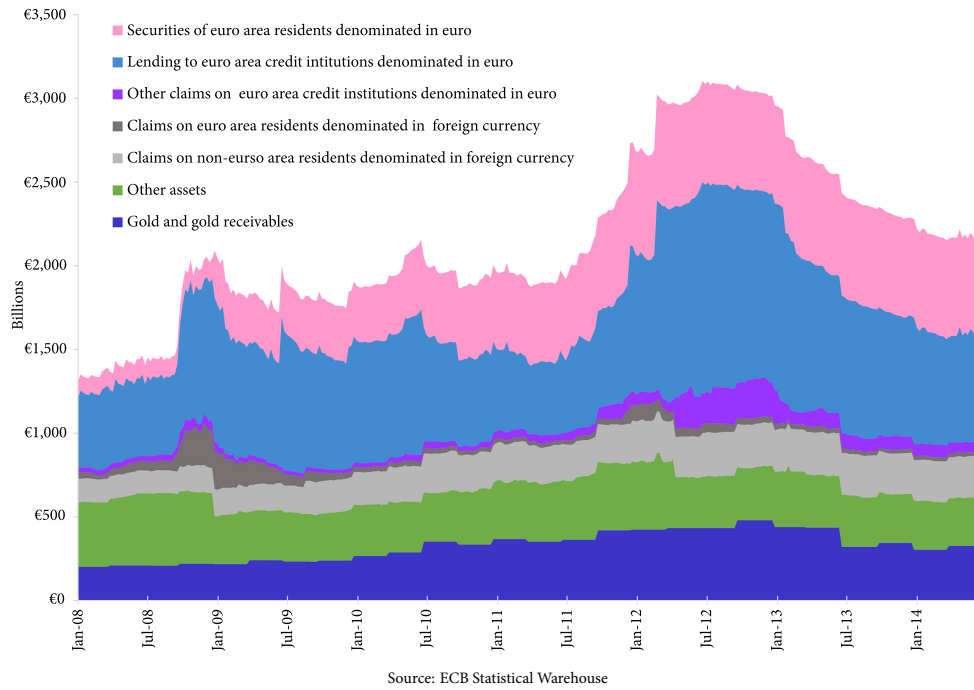
Regarding the impact of these policies, Darracq-Paries and Santis (2013) claim that LTROs were associated with increases in GDP, loan volume to non-financial corporations and a compression of lending rate spreads over the short and medium term. Beirne et al. (2011) find evidence that the CBPP did manage to reactivate the primary market and to significantly improve liquidity conditions in the secondary. Ghysels et al. (2014) construct an econometric model to study the ECB's intervention in the sovereign bond market and find the SMP successful in reducing yields and volatility of government bond of the implicated countries, in line with Eser and Schwaab (2013) who estimated an average impact per €1 billion of purchases on yields at the five year maturity, ranging from -1 to -2 bps in Italy to up to -17 to -21 bps in Greece.

It should be highlighted that all these non-conventional measures had a direct impact on the ECB's balance sheet. The fixed-rate tender with full allotment meant that banks could obtain as much liquidity as desired, and this contributed to the increase in the volumes loaned through refinancing operations, as did the easing of collateral required; by constituting asset acquisitions, the CBPP led to another increase on the asset side of the balance sheet, as well as the SMP. In the words of Stark (2009), member of the Executive Board of the ECB, "you could say that the ECB used its balance sheet to grant banks access to liquidity that was no longer available in the interbank market".

In Figure 1, the evolution of balance sheet components is represented. The boost following September 2008 is immediately observed, and is explained by the massive increase in the "Lending to euro area credit institutions", which grew close to 80% between the end of August and the end of October. Under this component are included the Main Refinancing Operations, the LTROs, VLTROs and other less significant operations. The component Securities of euro area residents denominated in euro also escalated, where the CBPP and SMP are accounted for.

In line with this observation, Gambacorta, Hofmann, and Peersman (2012) use a panel structural vector autoregressive, using central banks' assets as the policy variable, to study the macroeconomic impact of exogenous increases in central banks' balance sheet, in eight advanced economies. They argue that it indeed leads to a temporary rise in economic activity and consumer prices, but, interestingly, they find a larger output response relative to price than conventional monetary policy shocks usually generate, and the response peak of both variables coincide at around 6 months after the shock, while the response of prices to conventional shocks is usually much slower than the response of output. In contrast with this work project, however, they assume that only unconventional policy is in use, because of the reaching of the lower bound of policy rates, and thus do not include these on the model. Still, in the period analysed from Jan-

Figure 1: Evolution of the ECB's balance sheet



January 2008 and June 2011, the policy rate in the euro area was not at the zero lower bound (in fact, it has decreased since then), justifying the combined study of conventional and unconventional policy.

4 Data and Methodology

4.1 Identifying monetary shocks

Christiano, Eichenbaum, and Evans (1999) summarized the existing literature on isolating monetary policy shocks in three strategies. The first consists of designing identifying assumptions that allow estimation of the rule relating policymakers' decisions to the economic conditions. These assumptions relate to the set of variables taken into account by the central bank, and also to the way the shock interacts with the variables in the information set. The most standard approach is the recursiveness approach, which implies that if the central bank considers variables at time t when defining its shock at time t , then these variables are assumed to be unresponsive to realizations of the shock in time t .

The second approach, on the contrary, does not impose any assumption or model of the policy rule, instead it uses data that supposedly contains information on exogenous monetary policy

measures. Examples of this strategy can be found in Bernanke and Kuttner (2004) where the authors estimate the unexpected change in the target funds rate from the change in the rate of one month Federal Funds futures contract; in Romer and Romer (1989), the authors examine Federal Reserves records and identify contractionary shocks through a non—statistical narrative approach, by finding the times where the Fed attempted to induce a recession to reduce inflation.

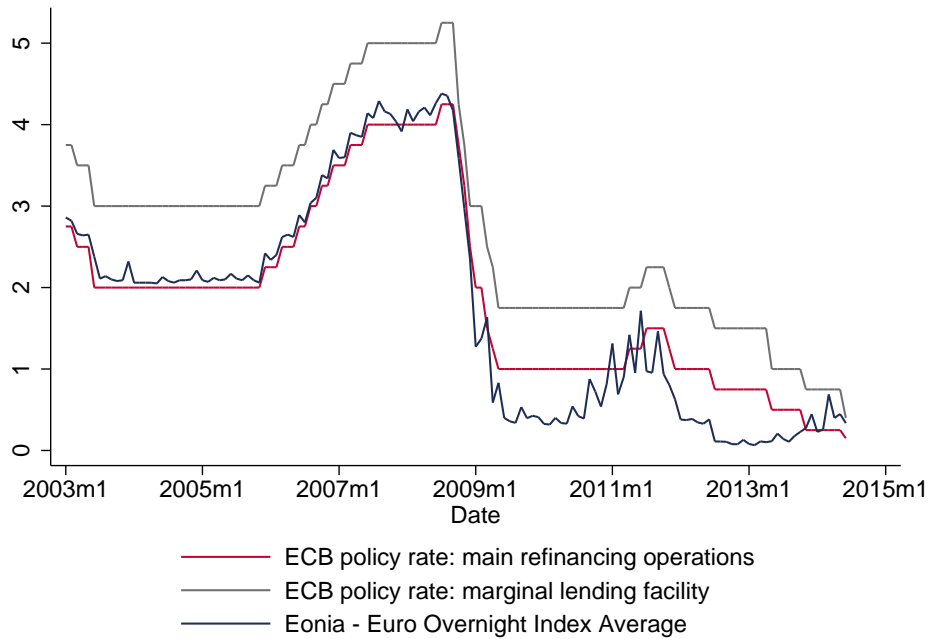
Finally, the third approach is to impose long-run restrictions having in mind that monetary policy shocks, being nominal, should not affect long term real effects. The identification procedure usually follows the scheme of Blanchard and Quah (1989). Still, consensus among researchers is yet to be reached and the recent modifications in the implementation of monetary policy poses an additional problem to the study of monetary policy transmission: how to distinguish and isolate conventional policy shocks and unconventional ones.

Answers to this question so far use the mentioned first approach of constructing a set of assumptions that separate the two types of shocks. In Japan, Kimura and Nakajima (2013) identify periods of unconventional policy regime, where the policy instrument is banks' reserves and thus shocks are deviations from the bank's rule linking macroeconomic shocks and reserves. The remaining periods are of conventional policy regimes, ; and where deviations from central bank's interest-rate rule linking inflation and output gap to the rate are the shocks. Then they use the latent threshold model by Nakajima and West (2013) to shrink the time-varying parameters to zero in the presence of the zero-lower bound, meaning that conventional shocks have no impact in the presence of the zero-lower bound.

Peersman (2011) employs a SVAR with zero and sign restrictions to identify both types of shocks, assuming that non-conventional shocks have zero impact on the policy rate, have a positive effect on credit volumes in the euro area and negative effect on the lending interest rate while conventional shocks are expansionary shocks that decrease the policy rate. Creel, Hubert, and Viennot (2013), on the other hand, regress the ECB's policy rate and the volumes of securities held for monetary purposes (the sum of SMP and CBPP) on a set of variables likely to be part of the information set of the ECB like past-values of GDP, GDP, inflation, oil prices, financial markets volatility among others and then use the residuals as the series of shocks. However, because the policy rules of conventional and unconventional shocks are likely to be similar, in the sense that the information set available to the policy maker is the same, this approach may not be enough to definitely identify the shocks.

My proposal to distinguish the two types of shock combines the second approach, of using data that by its essence contains data on monetary shocks to construct a series of conventional shock and the first, of using the *feedback rule* method, to identify the unconventional shocks. Next, these shocks will be incorporated in a Structural Vector Auto Regressive model, so that their effects on macroeconomic variables can be studied. This two-phased strategy allows me

Figure 2: ECB policy rates and the EONIA



to build the series of shocks before estimating any model, therefore minimizing the number of restrictions to be imposed on the SVAR.

4.2 Conventional Policy Shocks

The ECB policy rates are the interest rate on the main refinancing operations (MRO), that determines the cost of the least expensive money in the euro area and is thus the main policy rate; the rate on the deposit facility, which is the return eurozone banks receive on deposits with the ECB and the rate on the marginal lending facility, that is charged by the central bank for additional funds in case a financial institution is unable to raise liquidity in the interbank market. The marginal lending facility is usually 100 bp higher than the MRO rate (see Figure 2), as the marginal lending facility is a last resort option.

The Eonia (Euro Overnight Index Average) is very close to the policy rate as it is the average of rates from all overnight lending transactions realized between banks in euros, each day. As banks borrow euros from each other in the interbank market, the Eonia may slightly differ from the policy rate³ and indeed, it fluctuates around the policy rate. Between January 2003 and June 2014, the Eonia and the MRO rate hold a correlation of 97.78%. Therefore, as the Eonia

3. Namely because if the MRO rate is set as variable tender, then it only establishes a lower bound for transactions.

reflects and mimics evolutions in the ECB key policy rate, I will estimate monetary shocks using information from Eonia futures contracts.

I estimate two conventional shocks specifications, the first using the difference between the Eonia at month t and the 1-month futures rate at month $t - 1$ and the second given by the difference between the ECB MRO policy rate and the 1-month futures rate at month $t - 1$.

First, following Kleimeier and Sander (2006), I consider conventional monetary as a sum of expected and unexpected shocks

$$MP = MPU + MPE, \quad (1)$$

where MP is the observed key policy rate, MPE the expected and MPU the unexpected shocks. Using the Eonia as the MP, and the rate on its 1-month futures contracts as the MPE, I simply calculate the unexpected component of the monetary policy MPU subtracting MPE from MP. Due to data availability, average index are used which means the MPU may not be totally captured. Moreover, to use the Eonia futures contract as an MPE proxy implies assumptions on market agents, namely that they understand the policy actions of the ECB and on average are able to predict them accurately, meaning only *surprises* will generate differences between the future rate at time t and the realized rate at time $t + 1$. Thus, the shock is given by

$$\text{ConventionalShock1} = Eonia_t - F.Eonia_{t-1}. \quad (2)$$

The construction of the alternative conventional shock follows Gospodinov and Jamali (2014),

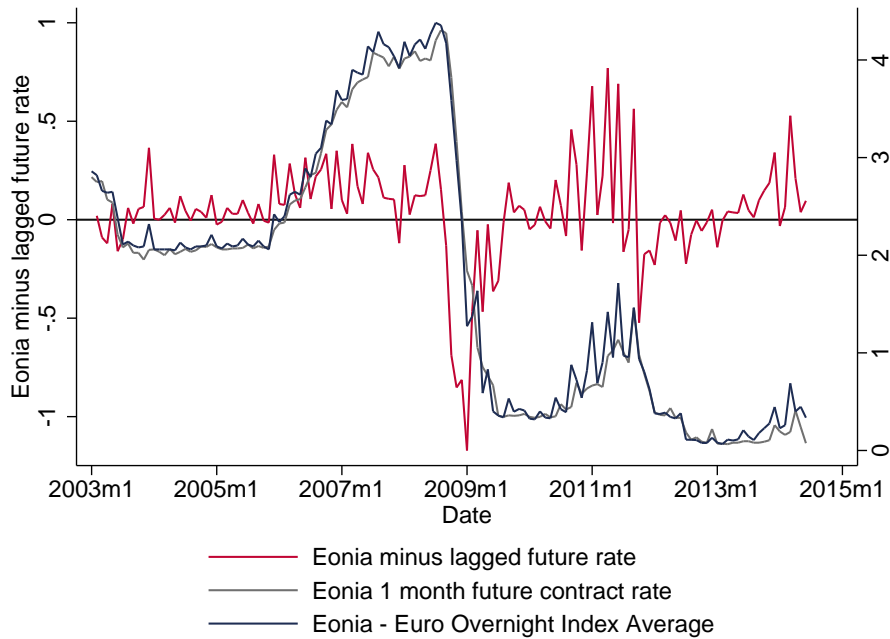
$$\text{ConventionalShock2} = ECBrate_t - F.Eonia_{t-1}, \quad (3)$$

where we again assume that Eonia futures contracts giving the expected rate in a month, also incorporate expected monetary shocks that impact the Eonia, as explained above. The shock is thus the difference between the *target* rate set by the ECB at time t and what markets predicted it would be, as of time $t - 1$.

Figure 3 plots the first specification of conventional shock, along with the policy rate, the Eonia and the futures rate. It shows a very strong expansionary shock on September 2008 that lasted until September 2009, which corresponds to the drop observed in the MRO policy rate until May 2009 and the maintenance of the rate at 1%. There are some contractionary (positive) shocks around January 2011 that probably signal unaccommodated tensions originating in the sovereign debt market.

Figure 4 shows the second estimated series of conventional shocks. A strong expansionary shock is also found in September 2008, but it only lasts until March 2009. Between April 2009

Figure 3: Conventional shocks 1 from Eonia and its futures



and December 2013, shocks are always positive, corresponding to a period where the Eonia (and thereby its future rate) were always below the policy rate, a consequence of the liquidity surplus caused by the fixed rate full allotment tendering arrangement in refinancing operations.

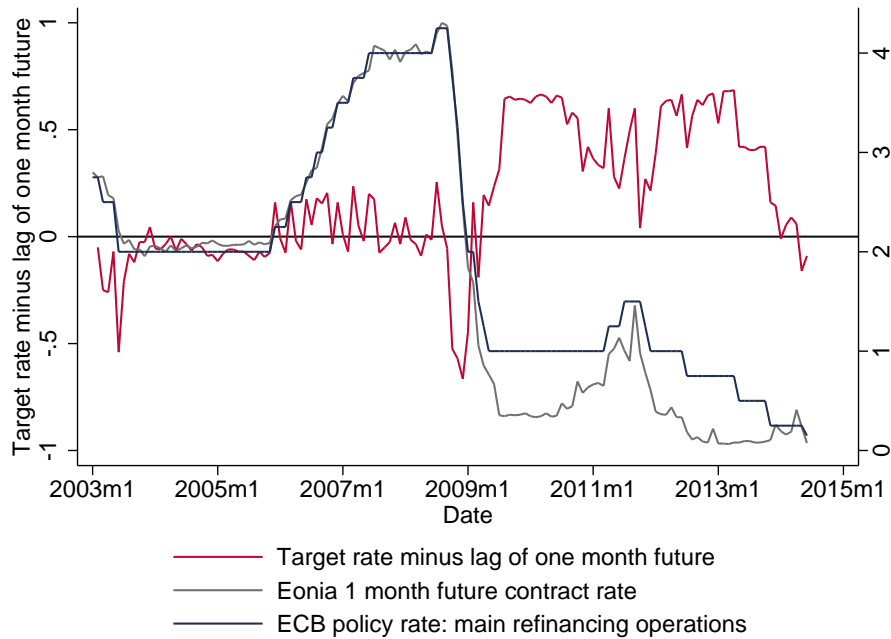
The fact that the second specification of conventional policy shocks reflects the switch from variable to fixed rate and full allotment liquidity provision, which are both non-standard measures:⁴, means the estimated shocks do not correspond, as desired, to the definition of unexpected shocks to the policy rate. In fact, the positive difference between the MRO rate and the Eonia futures throughout the mentioned period translates the ECB's new way of conducting open market operations, which cannot be identified as permanent shock and should only be reflected in the unconventional shock series. As such, I opt for the first specification of conventional shocks, which is the one to be used in the disentangling process that follows.

4.3 Unconventional Policy Shocks

As previously stated, the ECB's balance sheet size aggregates the enhanced credit provision measures and programmes such as the SMP and the CBPP, which may be categorized as quantitative easing. So, as the balance sheet became itself an instrument of monetary policy we might specify

4. Categorized as such by the European Central Bank.

Figure 4: Conventional shocks 2 from Key rate and Eonia futures



a policy rule that links its developments with the information set of the ECB to identify *unexpected shocks of unconventional policy*.

Once again, because the ECB defines its policy at the eurozone level, the information set shall only contain aggregated variables. Besides lags of euro area GDP, inflation, oil prices and euro area unemployment rate, like Peersman (2011) and Creel, Hubert, and Viennot (2013) I also add a measure of stock market index growth, the Composite Indicator of Systemic Stress (introduced by Holló, Kremer, and Lo Duca (2012), a measure of the current state of instability in financial markets), an aggregated measure of the cost of sovereign debt and of interest rates to new business loans. All these variables are included in a regression whose dependent variable is the ECB's balance sheet size as percentage of the euro area GDP. Finally, current conventional shocks and the current policy rate are also added as explanatory variables, under the assumption that conventional policy is prevalent to unconventional.

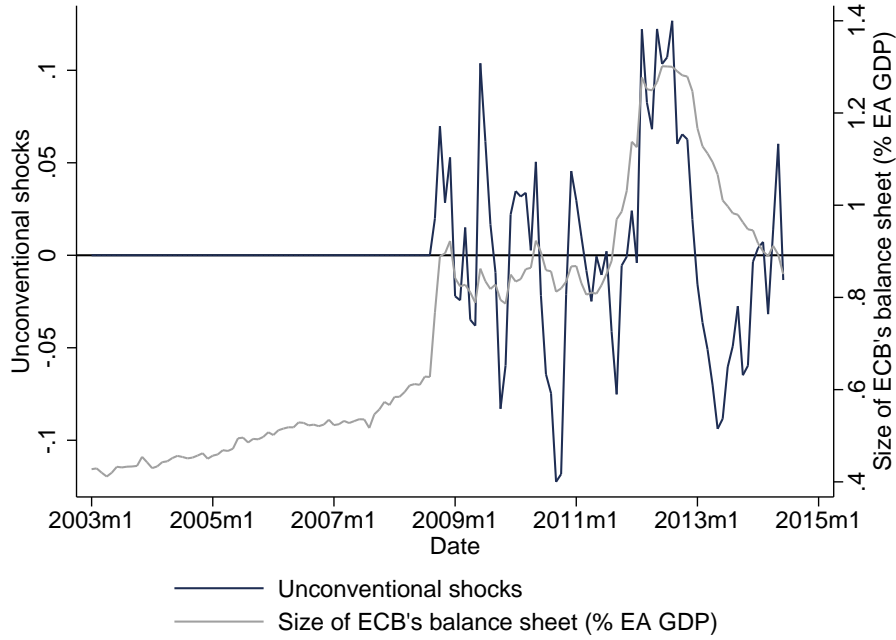
I then use the series of residuals from this regression as the unconventional shocks. Note that, because the previously identified shocks may also contain some information on policy actions other than changes in the policy rate, specially in the period where the Eonia dropped below the policy rate, the inclusion of the shocks in the regression guarantees that the residuals are orthogonal to this regressor, and thus constitute distinguished shocks. Variables are described

in Table 1 in the Appendix.

$$\begin{aligned}
SIZE_t = & \alpha_0 + \sum_{i=0}^p \alpha_2 GDP_{t-i} + \sum_{i=0}^p \alpha_1 CPI_{t-i} + \sum_{i=0}^p \alpha_3 Oil_{t-i} \sum_{i=0}^p \alpha_1 UR_{t-i} \\
& + \alpha_6 CISS_t + \alpha_7 STOX_t + \alpha_8 Credit_t + \alpha_9 Bonds_t \\
& + \sum_{i=0}^p \alpha_{10} ECBrate_{t-i} + \sum_{i=0}^p \alpha_{11} ConventionalShocks_{t-i} + \mu_t
\end{aligned} \tag{4}$$

Following the estimation of the shock series, values prior to September 2008 were set equal to zero, because the unconventional policy we aim to capture was only undertaken from that month onwards and so that the series represent policy actions taken specifically as a response to the financial crisis. Figure 5 is a plot of both the shock and the size of the ECB, a link between both series is observable with the exception of the period after May 2013 where shocks are less correlated with the size. The prominent shock of October 2008 corresponds to the extra liquidity provision adopted by the ECB as soon as the crisis took off. Another strong peak is observed in June 2009 corresponding to the launching of the CBPP. The largest positive shock found coincides with the second of three-year LTROs that took place in February 2012, where banks borrowed a total of €529.53 billion.

Figure 5: Estimated unconventional shocks and ECB's balance sheet size



4.4 The SVAR model

Structural Vector Autoregressive models are widely used to study the impact of monetary policy on macroeconomic variables since “identification of the effects of monetary policy shocks requires only a plausible identification of those shocks (...) and does not require identification of the remainder of the macroeconomic model”, as stated by Bernanke, Boivin, and Elias (2005).

The first specification presented in this thesis is designed to confirm whether the two series of conventional shocks estimated from the Eonia rate and the Eonia futures rate are in fact unexpected changes in the monetary policy rate. The hypothesis is as follows: if the estimated series indeed correspond to a series of monetary shocks, then a contractionary shock (a positive value) leads to a rise in short-term interest rates, a decrease in aggregate output and employment and a negative effect on the price level. The first benchmark model to be estimated includes the first differences of the employment rate ($D.Emp$), the consumer price index (CPI) and the shock:

$$X_t = \theta + \sum_{i=1}^p \gamma_i X_{t-i} + W_t + e_t, \quad (5)$$

where X_t is a vector of endogenous variables, θ a vector of constants, $\sum_{i=1}^p \gamma_i$ a matrix polynomial

in the lag operator and e_t the reduced-form VAR errors. Here, W is changes in the oil price and

$$X = \begin{bmatrix} D.Emp \\ CPI \\ Conventionalshocks_1 \end{bmatrix}. \quad (6)$$

$$W = \begin{bmatrix} OP \\ CISS \end{bmatrix}. \quad (7)$$

I assume a recursive identification scheme being that the structural errors are uncorrelated between themselves, and the identification of exogenous innovations relates reduced-form errors and structural errors through a lower triangular matrix. Establishing this matrix forces the covariance between the reduced form errors to be attributed to the structural error corresponding to the variable ordered previously in the X vector and makes the structural error uncorrelated to the reduced-form errors of the preceding variables. As such, because of the order specified above, the policy shock responds contemporaneously to shifts in the employment rate and in the price level while these latter only respond to monetary policy shifts with a lag.

To isolate from potential distortions of the post-financial crisis period, estimation will be computed from January 2003 until December 2007, on a monthly basis. Due to the reduced size of the sample period, the SVAR is performed with a small sample estimator and a small-sample degrees-of-freedom adjustment to the variance-covariance matrix. 4 lags are employed. Regarding the series included in the estimation, these are all stationary (see appendix, Table 2 and are described in Table 1). Estimated SVARS meet the eigenvalue stability condition.

The second specification to be estimated consists of a four variable SVAR using the previous identification scheme, where unconventional shocks are added before the series of conventional (because of the assumption of prevalence of the MRO rate over other policies). Therefore, the vector of endogenous variables is:

$$X = \begin{bmatrix} D.Emp \\ CPI \\ Unconventionalshocks \\ Conventionalshocks_1 \end{bmatrix}. \quad (8)$$

The sample of this model is between January 2008 and June 2014, in order to assess effects of different policies during and after the financial crisis. Again, 4 lags are employed. All the series included in the estimation are stationary (see appendix, Table 2). Estimated SVARS meet the eigenvalue stability condition.

Both SVAR models are highly parsimonious, given the constraint of a short sample period. The two specifications are estimated for each of the countries in the sample: Austria, Belgium, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, in addition to the euro area as an aggregate.

5 Results

5.1 Macroeconomic effects of policy rate shocks before January 2008

The estimation of the first SVAR specification aims at confirming whether the estimated shocks of the policy rate are indeed monetary shocks, in the sense that they produce the expected results on the employment level and on the consumer price index. Although some heterogeneity is expected, in line with findings of previous studies,⁵ there must be enough evidence of negative impact in both endogenous variables to accept them as conventional shocks.

In Figure 6, the impulse response functions (IRF) of both the employment rate and inflation to a conventional shock are plotted for all countries in the sample. Because the employment rate enters the SVAR in differences, the chosen IRF is a cumulative structural function, while for inflation simple structural functions are plotted.

Regarding the responses of inflation, the estimated reaction is much faster when compared with most results in the literature. In the majority of countries, peak effects are found before five months have passed since the initial shock, and responses seem to converge to zero after 10 months.

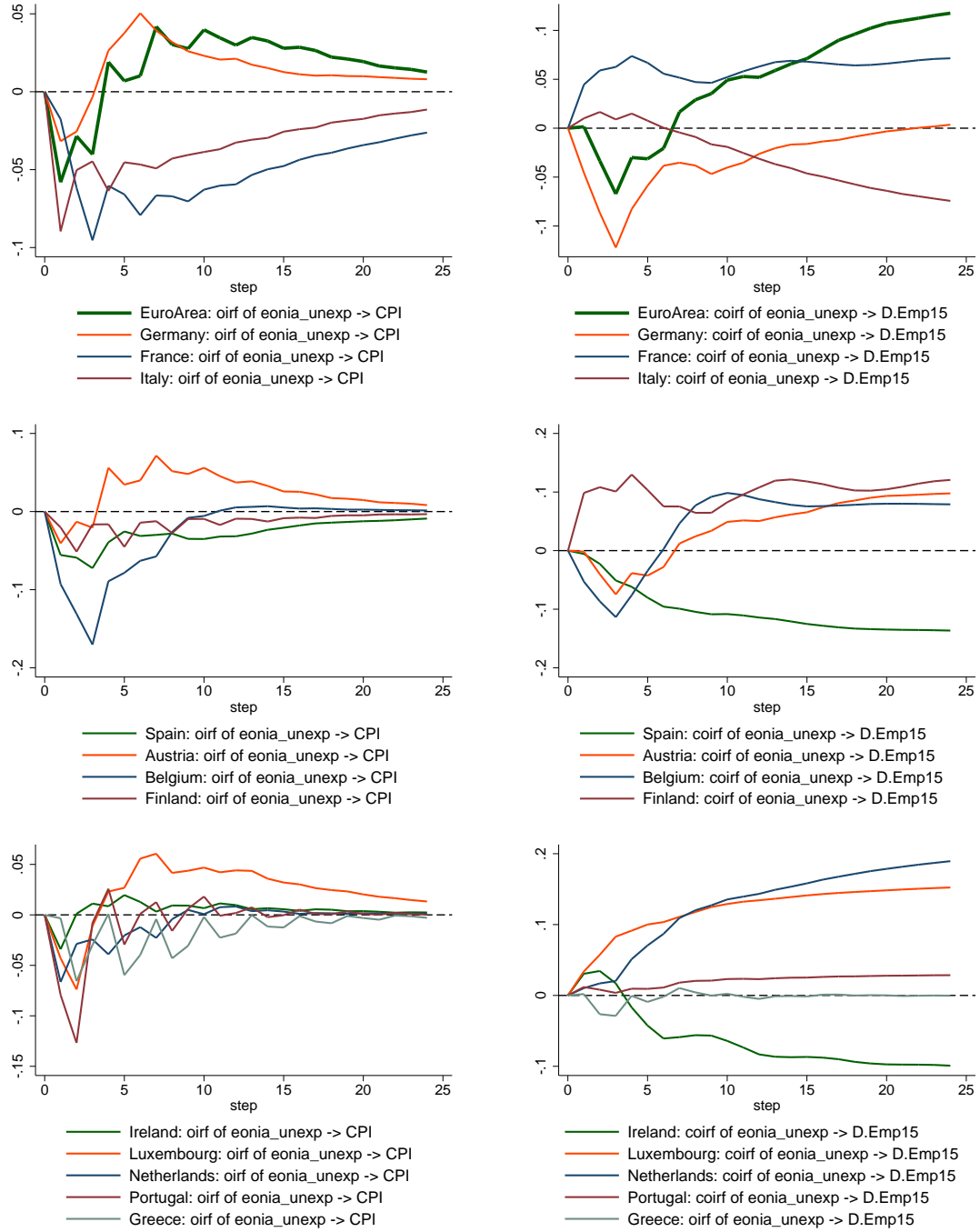
The Euro Area, Germany, Austria and Luxembourg constitute exceptions, being that they seem to have, after the initial four to five months, a sequence of *unexpectedly* positive responses. It should be noticed however, that both in Ireland, the initial negative effects are also followed by a period of positive responses, even if of smaller magnitude. Keeping in mind that the endogenous variable is CPI, annual rate of change in the consumer price index, the strongest responses are found in France, Italy, Belgium and Portugal, where the responses reach values close or slightly below -0.1 percentage points.

Looking at the responses of employment, evidence is rather mixed: 8 countries show a period of negative responses, whether immediately following the shock or after a certain number of months, while in Netherlands, Luxembourg, France, Finland and Portugal and the response is always positive.

In the euro area, in Germany, Belgium, Austria, Spain and Greece, response is already negative before five months have passed since the shock. Among these, in Belgium, Austria, and in the

5. De Santis and Surico 2013; Rafiq and Mallick 2008; Berger, Ehrmann, and Fratzscher 2006.

Figure 6: IRF of CPI and Employment to Conventional Shock 1



euro area, the effects turn positive after between five and ten months have passed. In Italy and Ireland, while the response is positive during the first five months, it is found negative after a larger number of steps.

While the results in the first mentioned four countries are quite puzzling, it may be worth remembering that Luxembourg has had the highest net migration rates in the eurozone over the past decade (with an average rate of net migration 12.4 from 2003 until 2008), whereas both France and Portugal have remarkably low flexibility in their labour markets. Given that the endogenous variable under study is the employment rate (number of people employed over total population aged 15-64), and that subtleties as immigration and labour market characteristics are not included in the model, these may partially explain the peculiar responses encountered.

Being that a negative response in CPI and in the employment rate is found across the majority of the countries in the sample, and that in the Euro-area, for which monetary policy is designed, initial effects are also negative; I find enough evidence to validate the estimated shocks as conventional monetary shocks and thereby, proceed with the estimation of the second SVAR.

A comment on heterogeneity in responses is, however, desired: it appears that monetary policy cannot explain cross country effects, as we find responses of opposite sign and significantly different dimension. This might be a consequence of the different state condition each country is in at the time of the shock, as aggregated policy cannot account for such different situations. Moreover, there can be spillovers between the various countries, for instance the larger negative response of Germany's employment rate might influence movement of workers to countries like France or Netherlands, where the response is positive. Characteristics of each country's transmission mechanisms, such as banks' lending adjustment or industry interest-rate sensitivity, are also essential in explaining the shape of responses, and thus in explaining the mixed results found.

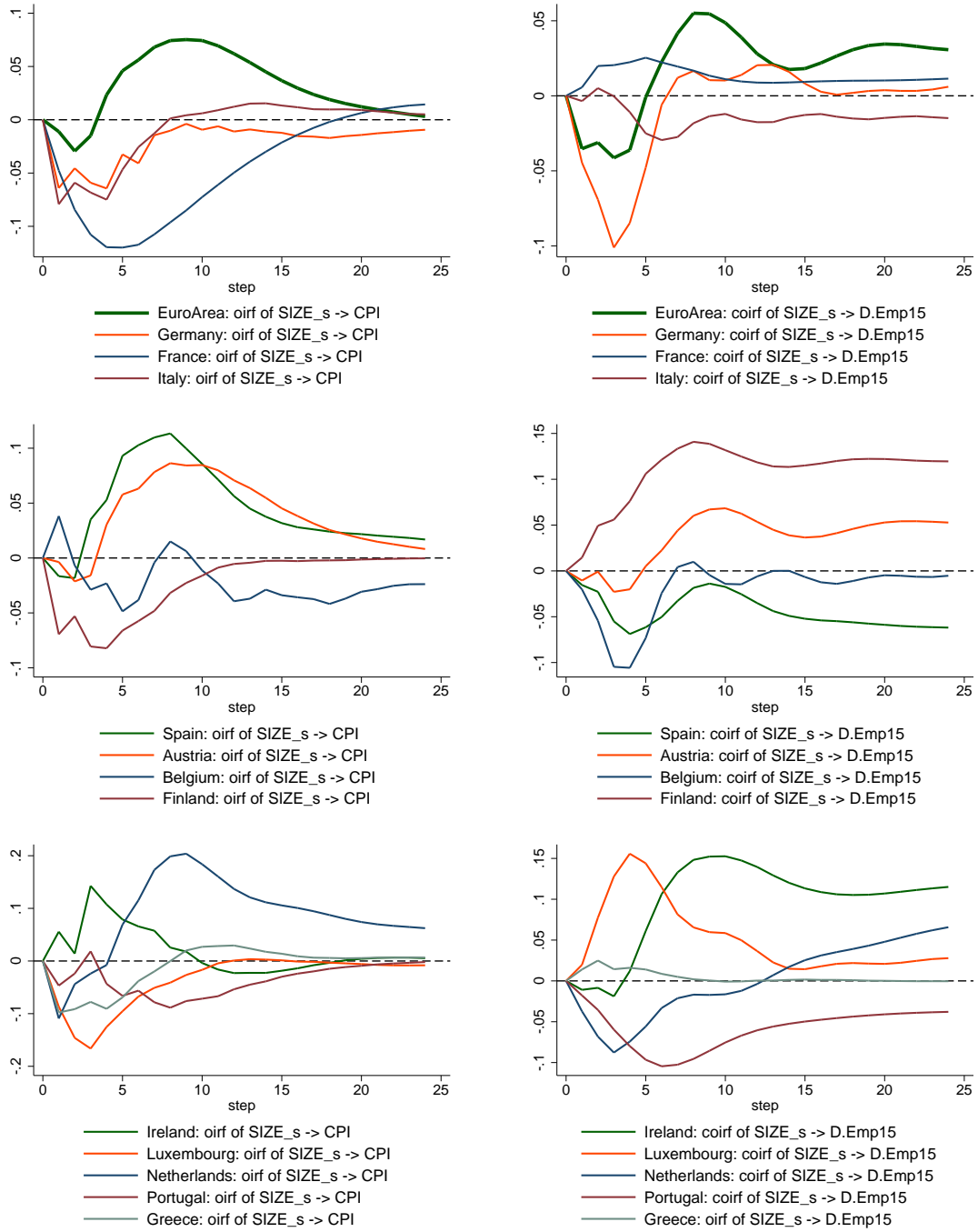
5.2 Macroeconomic effects of unconventional policy shocks after January 2008

Referring now to the crisis and post-crisis period, I discuss the impacts generated by unconventional policy shocks, which constitute the main object of interest of this paper.

The responses of CPI and the employment rate to unexpected shocks in the ECB's balance sheet size, the unconventional shocks, are found in Figure 7. The expected effects are now of opposite direction than in the previous computations, being that a positive unconventional shock should raise both inflation and the employment rate, in line with the intentions of the central bank when implementing such policies.

Looking at the IRF plots of CPI in Figure 7, heterogeneity between countries' responses seems

Figure 7: IRF of CPI and Employment to Unconventional Shocks, after 2008



to be quite large: while the Euro-Area, Spain, Austria, Ireland and Netherlands show definite positive responses; in Germany, France, Italy, Finland and Luxembourg and France, the effect on the price level growth is mostly negative for the entire two-year period considered.

Peak responses of CPI are found between 5 and 10 months in the euro area, France, Spain, Austria, the Netherlands and Portugal; while it is before five months have passed in the remaining countries. Even for countries with the highest peak responses (for instance, in Spain), the impact found is quite small being that an increment of 0.1 in the inflation rate represents only a minor development.

However, this happens because the impulse has the size of a standard deviation of the unconventional series, and as for the estimated series this corresponds the small value of .0546668, computed effects should also be limited in size. In fact, because impulse functions are linear, a larger shock will produce an equal response shape, only proportionally larger. Thus, I mainly focus on the sign of the responses rather than on their magnitude.

Finally, impact of unconventional shocks to the employment rate are found to be positive with the exception of Portugal and Spain. In Germany, Belgium and Netherlands response is negative, in the first 6, 7 and 13 months following the shock, respectively, and then the effect becomes positive although very weak in Germany and the Netherlands and virtually disappears in the case of Belgium. On the contrary, in Portugal and Spain, the negative effect appears to be permanent, as it converges to a negative value during the 24 steps plotted. Similarly to Belgium, in Italy the response is very close to zero throughout the whole step period but, besides an initial reduced positive effects, it appears to converge to a small but negative period. Greece is yet another case, where after 7 periods of positive but insignificant response, there is a clear convergence to zero.

Regarding the IRF plots of the other 6 areas, we find some endogeneity in the Euro-Area, Austria and Ireland in the sense that the initial effect (found one month after the shock) is slightly negative, to be followed by much larger positive reactions afterwards. In France, Finland and Luxembourg, the initial negative impact is not found. Peak responses are found in Finland, Luxembourg and Ireland.

Once again, the most relevant IRF, though, is that of the Euro-Area, as ECB policy is tuned to aggregated macroeconomic conditions. Confirming that the estimated shocks are indeed unconventional policy innovations, we find a clear, smooth and relatively long-lasting positive response in CPI and a definite positive response in the employment rate after 5 periods (labour market is usually sluggish).

Responses in the individual countries are mixed because of previously mentioned reasons: spillovers, inadequacy of policy stance and magnitude, and different transmission mechanisms.

Of the countries where permanent effects are negative (Italy, Spain and Portugal), all were un-

der severe sovereign debt financial stress, and were thus subject to more severe macroeconomic conditions due to austerity policies and financing difficulties. In Greece, another country that underwent a relentless macroeconomic crisis, the response is almost zero. Thus, responses to unconventional shocks in these four countries were definitely not positive. Among the countries most affected by the sovereign debt crisis of 2011, apparently only Ireland benefited from the unconventional monetary policy measures taken. This might mean that those measures were not enough to compensate for the macroeconomic disequilibrium lived in the remaining four nations. This might be the case even though it is also true that the use of the LTRO facility has benefited these nations the most, with around 70% to 80% of the total lending being borrowed by banks of these five countries, since 2010 (Claeys 2014).

6 Conclusion

The main goal of this work project is to evaluate the macroeconomic impact of the unconventional policy pursued by the ECB since September 2008. I find that the policy shocks were able to accelerate CPI at the aggregated level and in some countries (Austria, Spain, Ireland and Netherlands). Regarding employment, although at the eurozone level and in some countries responses were positive as desired (France, Finland, Austria, Ireland and Luxembourg), in the countries facing stronger economic distress following the crisis (Portugal, Spain, Greece and Italy), the absence of positive effects indicates that unconventional policy measures were not enough in magnitude or in extension to generate significant positive reactions, that could efficiently stimulate these economies.

References

- Angeloni, Ignazio, and Michael Ehrmann. 2003. *Monetary policy transmission in the euro area: any changes after EMU?* Working Paper Series 0240. European Central Bank.
- Beirne, John, Lars Dalitz, Jacob Ejsing, Magdalena Grothe, Simone Manganelli, Fernando Monar, Benjamin Sahel, Matjaž Sušec, Jens Tapking, and Tana Vong. 2011. *The impact of the Eurosystem's covered bond purchase programme on the primary and secondary markets*. Occasional Paper Series 0122. European Central Bank, January.
- Berger, Helge, Michael Ehrmann, and Marcel Fratzscher. 2006. *Forecasting ECB monetary policy: accuracy is (still) a matter of geography*. Working Paper Series 0578. European Central Bank.
- Bernanke, Ben S. 1993. "Credit in the Macroeconomy." *Federal Reserve Bank of New York Quarterly Review* 18 (1): 50–70.

- Bernanke, Ben S., and Alan S. Blinder. 1988. "Credit, Money, and Aggregate Demand." *American Economic Review* 78 (2): 435–39.
- Bernanke, Ben S., and Kenneth N. Kuttner. 2004. *What Explains the Stock Market's Reaction to Federal Reserve Policy?* NBER Working Papers 10402. National Bureau of Economic Research, Inc, April.
- Bernanke, Ben, Jean Boivin, and Piotr S. Elias. 2005. "Measuring the Effects of Monetary Policy: A Factor-augmented Vector Autoregressive (FAVAR) Approach." *The Quarterly Journal of Economics* 120, no. 1 (January): 387–422.
- Blanchard, Olivier Jean, and Danny Quah. 1989. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." *American Economic Review* 79, no. 4 (September): 655–73.
- Bondt, Gabe de. 2002. *Retail bank interest rate pass-through: new evidence at the euro area level*. Working Paper Series 0136. European Central Bank.
- Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans. 1999. "Monetary policy shocks: What have we learned and to what end?" Chap. 2 in *Handbook of Macroeconomics*, edited by J. B. Taylor and M. Woodford, 1:65–148. Handbook of Macroeconomics. Elsevier.
- Ciccarelli, Matteo, Angela Maddaloni, and José-Luis Peydró. 2013. *Heterogeneous transmission mechanism: monetary policy and financial fragility in the euro area*. Working Paper Series 1527. European Central Bank.
- Claeys, Grégory. 2014. *The (not so) Unconventional Monetary Policy of the European Central Bank since 2008*. In-Depth Analysis. European Parliament, February.
- Cordemans, N., and M. de Sola Perea. 2011. "Central bank rates, market rates and retail bank rates in the euro area in the context of the recent crisis." *Economic Review*, no. I (June): 27–52.
- Creel, Jérôme, Paul Hubert, and Mathilde Vienne. 2013. *Assessing the interest rate and bank lending channels of ECB monetary policies*. Documents de Travail de l'OFCE 2013-25. Observatoire Français des Conjonctures Économiques (OFCE), December.
- Darracq-Paries, Matthieu, and Roberto De Santis. 2013. *A non-standard monetary policy shock: the ECB's 3-year LTROs and the shift in credit supply*. Working Paper Series 1508. European Central Bank.
- De Santis, Roberto A., and Paolo Surico. 2013. "Bank lending and monetary transmission in the euro area." *Economic Policy* 28 (75): 423–457. doi:10.1111/1468-0327.12013.

- Eser, Fabian, and Bernd Schwaab. 2013. *Assessing asset purchases within the ECB's securities markets programme*. Working Paper Series 1587. European Central Bank, September.
- Gambacorta, Leonardo, Boris Hofmann, and Gert Peersman. 2012. *The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis*. BIS Working Papers 384. Bank for International Settlements, August.
- Ghysels, Eric, Julien Idier, Simone Manganelli, and Olivier Vergote. 2014. *A high frequency assessment of the ECB securities markets programme*. Working Paper Series 1642. European Central Bank.
- Gospodinov, Nikolay, and Ibrahim Jamali. 2014. *The Response of Stock Market Volatility to Futures-Based Measures of Monetary Policy Shocks*. Working Paper 2014-14. Federal Reserve Bank of Atlanta, August.
- Holló, Dániel, Manfred Kremer, and Marco Lo Duca. 2012. *CISS - a composite indicator of systemic stress in the financial system*. Working Paper Series 1426. European Central Bank.
- Kimura, Takeshi, and Jouchi Nakajima. 2013. *Identifying Conventional and Unconventional Monetary Policy Shocks: A Latent Threshold Approach*. Bank of Japan Working Paper Series 13-E-7. Bank of Japan, May.
- Kleimeier, Stefanie, and Harald Sander. 2006. "Expected versus unexpected monetary policy impulses and interest rate pass-through in euro-zone retail banking markets." *Journal of Banking & Finance* 30 (7): 1839–1870. doi:10.1016/j.jbankfin.2005.07.006.
- Mundell, Robert A. 1968. "A Theory of Optimum Currency Areas." In *International Economics*, 177–18. New York: Macmillan.
- Nakajima, Jouchi, and Mike West. 2013. "Bayesian Analysis of Latent Threshold Dynamic Models." *Journal of Business & Economic Statistics* 31, no. 2 (April): 151–164.
- Peersman, Gert. 2011. *Macroeconomic effects of unconventional monetary policy in the euro area*. Working Paper Series 1397. European Central Bank, November.
- Rafiq, M.S., and S.K. Mallick. 2008. "The effect of monetary policy on output in EMU3: A sign restriction approach." *Journal of Macroeconomics* 30, no. 4 (December): 1756–1791. doi:10.1016/j.jmacro.2007.12.003.
- Romer, Christina D., and David H. Romer. 1989. "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz." In *NBER Macroeconomics Annual 1989, Volume 4*, 121–184. NBER Chapters. National Bureau of Economic Research, Inc, December.

- Sørensen, Christoffer Kok, and Thomas Werner. 2006. *Bank interest rate pass-through in the euro area: a cross country comparison*. Working Paper Series 0580. European Central Bank.
- Stark, Jürgen. 2009. *Monetary Policy before, during and after the financial crisis*. Speech by Jürgen Stark, Member of the Executive Board of the ECB, at the University of Tübingen, November.
- Stiglitz, Joseph E., and Andrew Weiss. 1981. "Credit Rationing in Markets with Imperfect Information." *American Economic Review* 71 (3): 393–410.

7 Appendix

Table 1: Data Description

Name	Variable	Construction	Source
ECBrate	Interest rate on the main refinancing operations (MRO)	Rate at the end of the month	ECB
Eonia	Euro OverNight Index Average	Monthly Average Rate	Bloomberg
F.Eonia	1 Month Future rate on Euro OverNight Index	Monthly Average Rate	Bloomberg
Size	Size of ECB's Balance sheet as % of euro area GDP	Monthly rate	ECB
GDP	Euro area GDP	Interpolated level from quarterly data	ECB
UR	Euro Area unemployment rate, total	Monthly rate	Eurostat
OP	Oil price, Brent crude oil 1 month forward in euro	Year on Year Percentage Change	ECB
CISS	Composite Indicator of Systemic Stress	Index	ECB
STOXX	Dow Jones Euro Stoxx 50 Price Index (Historical close, average of observations through period)	Index	ECB
Credit	Euro Area annualised agreed rate of loans to NFC and Households	Monthly Rate	ECB
Bonds	Euro area 10-year Government Benchmark bond yield	Annualised Monthly Rate ECB	ECB
Emp	Employment rate, Employed persons over total population aged 15-64	Monthly Rate, interpolated	Eurostat
CPI	Harmonised Index of Consumer Prices (HICP) Overall index, Neither seasonally nor working day adjusted	Annual rate of change	Eurostat

Table 2: Dickey–Fuller test results

Country	Variable	MacKinnon p -value (up to 2007m12)	MacKinnon p -value (up to 2014m06)
EuroArea/common	ConventionalShocks	0.0309	0.0024
	UnconventionalShocks	—	0.0098
	OP	0.0000	0.0012
	D.Emp	0.0003	0.0000
	CPI	0.0014	0.0309
Austria	D.Emp	0.0003	0.0000
	CPI	0.0999	0.0364
Belgium	D.Emp	0.0051	0.0000
	CPI	0.0088	0.0098
Finland	D.Emp	0.0000	0.0000
	CPI	0.0521	0.0195
France	D.Emp	0.0000	0.0000
	CPI	0.0160	0.0087
Germany	D.Emp	0.0226	0.0001
	CPI	0.0714	0.0336
Greece	D.Emp	0.0002	0.0638
	CPI	0.0013	0.0562
Ireland	D.Emp	0.0007	0.0500
	CPI	0.0092	0.0203
Italy	D.Emp	0.0120	0.0019
	CPI	0.0133	0.0953
Luxembourg	D.Emp	0.0737	0.0003
	CPI	0.0042	0.0179
Netherlands	D.Emp	0.0190	0.0031
	CPI	0.0001e	0.0834
Portugal	D.Emp	0.0013	0.0319
	CPI	0.0083	0.0467
Spain	D.Emp	0.0051	0.0424
	CPI	0.0068	0.0355

All variables are stationary within each specified period under a significance level of 10%, as p -values fall below this value.